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# Improving documentation of prescriptions for as-required medications in hospital inpatients

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## ABSTRACT

It is estimated that 1 in 10 hospital inpatients in Scotland have experienced a medication error. In our unit, an audit in 2019 identified documentation of as-required prescriptions on drug Kardexes as an important target for improvement. This project aimed to reduce the percentage of these errors to <5% in the ward in 6 months.

Weekly point prevalence surveys were used to measure medication error rates over a 12-week baseline period. Errors in route, frequency of dose and maximum dose accounted for >80% of all prescribing errors. The intervention was a poster reminder about the three most common errors linked to standards for prescribing pain medication. Barriers to change were identified through inductive thematic analysis of semistructured interviews with five ward doctors and two staff nurses.

In the 6 weeks after intervention, our run chart showed a shift in maximum dose errors per patient, which fell from 75% to 26%. However, route and frequency errors remained high at >70% per patient. Most of these errors were due to use of abbreviations, and qualitative interviews revealed that senior doctors and nurses believed that these abbreviations were safe. We found some evidence from national guidelines to support these beliefs.

Overall, the intervention was associated with decreased prevalence of patients without a maximum dose written on their prescription, but lack of space on drug prescriptions was identified as a key barrier to further improvement in both maximum dose and abbreviation errors.

## PROBLEM

Inaccurate prescription documentation has the capacity to cause severe patient harm. A ward underwent audit of its patients' Kardexes in mid-2019 to assess the scale of this problem, with feedback of results to the clinical team. Despite the existence of health board-wide prescribing guidelines in NHS Tayside,<sup>1</sup> as-required or *pro-re-nata* (PRN) medications were found to be the poorest prescribed drugs, with accuracy between 20% and 40%. This was identified as an important target for improvement.

The ward is a 16-bed unit consisting of elective surgical patients, patients with cancer and emergency admissions with different prescribing demands. These patients often

require pain medication and other as-required drugs such as antiemetics. The ward's 3 monthly rotational intake of foundation year 1 (FY1) doctors was thought by the project team to have compounded the problem of inaccurate as-required prescribing as most prescribing in the ward is completed by doctors of this level. This project aimed to reduce the percentage of documentation errors of as-required medications in the ward within the 6-month intervention period.

## BACKGROUND

Most prescriptions in UK hospitals are written by doctors in their first two FY of training. Two large UK studies reported errors in 7.4%–8.4% of prescriptions written by FY doctors. Most patients in hospitals have more than one prescription, and consequently the prescription error rate per patient was 32%–50%.<sup>2,3</sup> The most common suggested causes for these errors were in the work environment such as workload, interruptions, pressure from staff, cross-cover between wards and low staffing. Amongst individual factors, tiredness and stress were more frequent than insufficient knowledge or prescribing skills.<sup>2</sup> Doctors have been found to adjust their performance to combat day-to-day challenges such as lack of time in the interest of patient safety; use of abbreviations would be an example of this.<sup>4</sup> Areas of as-required prescribing that were commonly missed in studies on prescription documentation were 'indication of drug' and 'frequency of dose'.<sup>5,6</sup> These are examples of how doctors may skip what they deem as 'less essential' components of a prescription in the interest of saving time.

Prescribing is a four-step series of tasks: prescribing, transcribing, dispensing and administration.<sup>6</sup> Each of these steps involves its own risks; however, evidence suggests that most errors occur in the 'prescribing' and 'administration' phases.<sup>6–8</sup> A medication error is generally defined as an error occurring in any of these steps, whereas a prescription error



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occurs solely in the ‘prescribing’ phase.<sup>9</sup> Prescribing can be further specified into regular medications (drugs the patient takes every day) and as-required medications (for symptomatic relief). Although as-required prescriptions are most commonly for pain, other common indications for this are nausea and vomiting, anxiety and allergies.<sup>10</sup> A systematic review identified very little evidence about the safety or effectiveness of as-required prescriptions in comparison with regular prescriptions and suggested that PRN safety issues and adverse events are under-recognised.<sup>7 10</sup> PRN medications require more written information than regular medications, creating more opportunities for error. The prescriber must include the indication for the drug, its frequency and its maximum dose in 24 hours. If these steps are not completed, the drug may be administered incorrectly, resulting in serious harm to the patient. Despite this, literature is scarce on how to improve PRN prescribing.<sup>11 12</sup> Some work has been done into evaluating the efficacy of PRN prescribing in psychiatric units; however, there is limited evidence of audit into how well these medicines are prescribed for indications such as pain and nausea, which form the bulk of PRN prescriptions on our ward.<sup>13</sup>

## MEASUREMENT

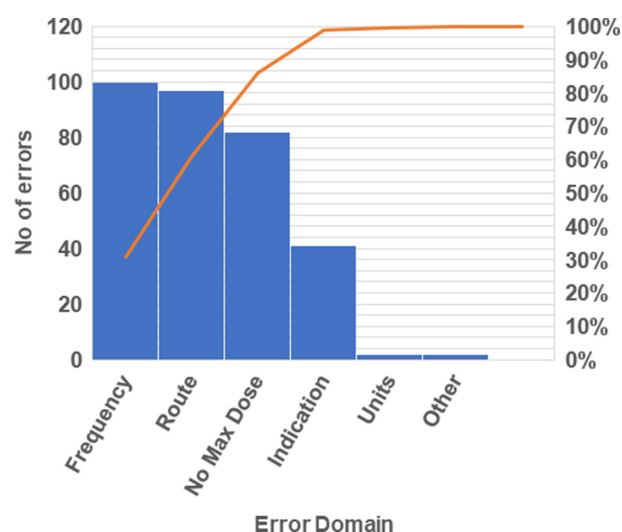
### Quantitative methods

Initial data collection using a point prevalence survey (PPS) took place in the ward over a period of 8 weeks to quantify the number of errors in the as-required section of each patient’s Kardex. An average of seven Kardexes were assessed each week using a structured template (online supplemental material 1). Errors were classified using NHS Tayside prescribing guidelines. This guideline does not include a full list of accepted abbreviations; however, it does include strict guidelines on how to document the route of administration appropriately and rejects ‘PO’ as an appropriate abbreviation for ‘oral’ (online supplemental material 2). The guideline also specifically states that ‘Latin or other abbreviations must not be used’ and that the frequency of dose must be written in full. Furthermore, the guideline recommends that for as-required medicines, the prescriber ‘must state the indication and give a clear statement of dose, maximum frequency, and the maximum dose to be administered in each 24-hour period’.<sup>1</sup>

The selected error domains based on these guidelines were no maximum dose included, improperly or omitted route of drug, improperly written or omitted indication of drug, improperly written or omitted frequency of dose, improperly written or omitted units of dose and ‘other’, which comprised any documentation error outside of the set domains.<sup>1</sup>

A primary outcome measure and a process measure were calculated from our PPS data:

**Primary outcome measure:** Percentage of patients on the ward with an as-required drug entry error.



**Figure 1** Pareto chart of number of as-required drug entry errors by domain in the preintervention period.

**Process measure:** Number of as-required drug entry errors.

Of the Kardexes assessed at baseline for our primary outcome measure, a median of 50% of patients had an as-required prescription with an error. The most common errors were in the domains of route, frequency and maximum dose. The most common causes of these errors were omission of maximum dose or use of unsuitable abbreviations. The most common unsuitable abbreviations used were ‘PO’ instead of ‘oral’ when documenting drug route and a degree sign (°) written in place of ‘hourly’ when noting frequency. Pareto chart analysis of our process measure results in the preintervention period showed that over 80% of errors occurred in these three domains (figure 1).

We utilised the 80:20 rule when conducting our Pareto chart analysis, which states that about 80% of effects come from 20% of the causes.<sup>14 15</sup> According to the chart, route, frequency and maximum dose errors were what contributed the most to the total number of PRN prescribing errors on the ward.

The intended outcome of the intervention was a reduction in adverse drug events, which was our intended process measure. This was emphasised in the poster statement ‘don’t put your patients at risk’ (online supplemental material 3). However, we could not measure adverse drug events for two reasons. First, they are uncommon; harm to patients occurs in <1% of undetected prescribing errors in hospitals.<sup>16</sup> Consequently, large studies are required to detect the impact of medication safety interventions on patient outcomes.<sup>17</sup> Second, the only available information about adverse drug events was the hospital’s system for reporting patient safety incidents. However, a study of 1006 admissions to an NHS hospital in England found that only 33 (11%) of 303 adverse events identified through case note review were reported on the hospital’s reporting system.<sup>18</sup>

We used qualitative methods to provide a balanced account of beliefs and attitudes about the intervention.<sup>19</sup> We did not include quantitative balancing measures.

### Qualitative methods

Qualitative semistructured interviews were conducted with five doctors and two nurses with informed consent. Interviews lasted approximately 20–30 min and were audio-recorded to allow for verbatim transcription. They took place in staff offices (n=3) and the ward's family room (n=4) to ensure confidentiality for our participants. Interviewees were not provided with any information or sources about the topic prior to the interview.

Interviews used specific topic guides for doctors (online supplemental material 4) and nurses (online supplemental material 5) to ensure all key questions were covered while keeping the interview open to new ideas. The questions asked in the interview focused on confidence in writing (for prescribers) or reviewing (nurses) as-required prescriptions. This was because staff availability issues meant that some interviews (n=3) could not be undertaken in the postintervention period. As a result, our qualitative findings focused less on the effect of our intervention and more on staff opinions of PRN prescribing and its capacity for errors. Interview transcripts were uploaded to NVivo V.12, and data management, coding and initial analysis were conducted using this software. Inductive approaches were used throughout the thematic analysis of the transcript to allow the interviewees' themes to arise from their own discussions.

### DESIGN

A small quality improvement (QI) team consisting of a medical student (SR) and a consultant (YB) was formed. Patients were not involved in the design, conduct, reporting or dissemination plans of our research as this was not feasible given the time frame for the project. Environmental factors for inaccurate PRN prescribing were identified through creation of a cause-and-effect diagram (see online supplemental material 6) using findings from two ward observation sessions conducted by the project lead (SR). These were applied to the COM-B Model of Behaviour to identify target barrier behaviours for a behavioural diagnosis.<sup>20</sup> From our analysis of the model (online supplemental material 7), 'opportunity' was found to be the dominant COM-B component in which barrier behaviours to accurate PRN prescribing were driven, with 'physical opportunity' in the context of the ward environment emerging as the dominant barrier behaviour. This information was then applied to Michie's Behaviour Change Wheel.<sup>20</sup> We identified three potential intervention functions—persuasion, incentivisation and coercion—through the means of either environmental or social planning, communication, marketing or legislation. The busy nature of the ward meant that junior doctors required a quick and effective tool to help them with PRN prescriptions. A poster intervention was

selected as the team felt it was a good combination of each intervention function and was manageable given the time frame for the project. Most prescribing took place in the ward's doctors' room; therefore, a poster in this location was most suitable for our target population to maximise ease of access.

Our poster was developed using NHS Tayside's prescribing 'pain ladder' guideline, which contains our health board's recommended pain medication for patients across all specialties who have mild, moderate or severe pain.<sup>21</sup> The poster also focused on prevention of errors in the three main error domains identified from our baseline data collection (online supplemental material 3). The poster was laminated and put up in the doctors' room as well as other key areas where prescribing tasks were known to take place.

Data collection was reinitiated after the introduction of the poster and was conducted in the same fashion as the preintervention data to assess for improvement in as-required prescribing. Plan-do-study-act (PDSA) cycles were used to monitor the intervention and provide modifications where appropriate (online supplemental material 8).

### STRATEGY

Our SMART aim was to decrease as-required documentation errors on drug Kardexes to <5% by April 2020. We used a set of PDSA cycles to monitor and adapt our intervention design to ensure our method was suitable for the ward environment.

Our data collection method was a weekly PPS using a template (online supplemental material 1) to gain a 'snapshot' of patient Kardexes at a set time each week. It was predicted that collecting data in this way would give the team an understanding of the rate at which PRN prescribing errors occurred on the ward.

### PDSA cycles

A poster was introduced to the ward to remind doctors of best practice when prescribing as-required medications. The project team wanted to maximise the potential of the intervention through PDSA cycles. These represent planning (PDSA 1.1) and design (PDSA 1.2) of the poster and redevelopment of the poster using cues from the internal environment and staff behaviours (PDSA 1.3).

PDSA cycle 1.1 (October 2020): The team planned to use up-to-date pain guidelines to form the content of our poster. We searched various guidelines to create the template; however, no updated material was available. The team thought this was because the content was being accessed via a personal computer instead of an NHS computer. We accessed an NHS computer with Staffnet to print out the most recent pain ladder guidelines for Tayside; this was then used as a template to create a pain ladder poster.<sup>21</sup>

PDSA cycle 1.2 (November 2020): An A4 poster was created and put up on the doctors' room noticeboard.



Ward prescribers and reviewers were informed about the poster and its purpose to ensure staff knew where to seek help if they needed it. One week after the poster was introduced to the noticeboard, it had been moved by a member of staff behind other guidelines on the wall. A new location was sought to prevent staff tampering with the poster.

PDSA cycle 1.3 (November–December 2020): The poster was laminated to increase its durability and had bolder colours to attract the eye of FY1s working at their station. More posters were printed out and added to other areas of the ward where prescribing was known to take place, such as the dispensing room and the nurses' tables at the end of each bed bay. Staff were informed of the new locations of the posters. One week later, there was no further movement of the posters. These locations triggered a slight improvement in PRN prescribing as after intervention there was a 39.2% decrease in the number of prescribing errors on patients' Kardexes.

Additional details for each PDSA cycle are in online supplemental material 8.

## RESULTS

### Qualitative results

From the quantitative baseline data, the two most common error domains were that of 'frequency' and 'route' because of the use of abbreviations (figure 1). The most common term used to abbreviate the frequency of dose was a degree (°) sign in place of writing out 'hourly' in full, and the most common abbreviation found in the 'route' domain of the Kardex was 'PO' in place of writing out 'oral'. These were the most common prescribing errors seen throughout the entire data collection process. Staff opinions were investigated using semistructured qualitative interviews with ward staff to discover whether they thought using abbreviations on drug Kardexes was appropriate.

In summary, interviewees used abbreviations in the Kardex for three main reasons: common knowledge, habit and because of physical barriers such as lack of space to write a full prescription. Although physical barriers and habit were justifiable reasons for abbreviating prescriptions from the data, there were discrepancies between the doctors' and nurses' opinions on how easily their prescriptions were interpreted by nursing staff, with illegibility being a key issue for Staff Nurse A. Interview data provided significant evidence that there was an abbreviations-supportive culture on the ward resulting from these contributing factors. This provided the team with insight as to why the quantitative errors detected were most often from abbreviations of drug route and frequency. Qualitative interviews also provided us with information on why maximum dose was often missed out by prescribers; this was because it involves a lot of writing in a small space. Hierarchical themes from the interviews are summarised in online supplemental material 9.

### Quantitative results

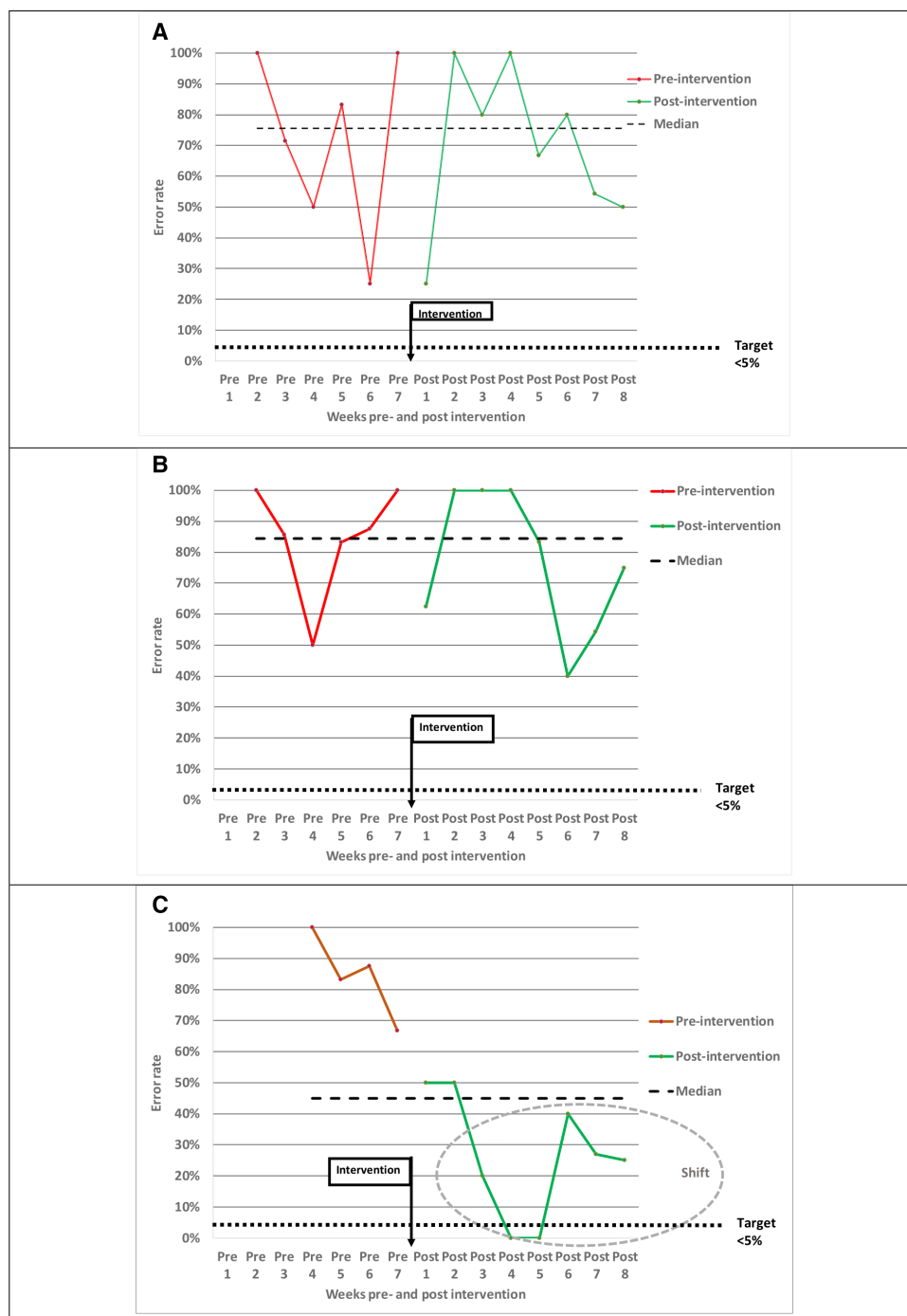
Results for our outcome measure data preintervention and postintervention were expressed in the form of run charts for each error domain: route, frequency and maximum dose. Results were collated into preintervention weeks (1–7) and postintervention weeks (1–8). Data for preintervention week 1 were not formally recorded as pilot data collection took place at this time. Data for maximum dose errors were not recorded until preintervention week 4 because this information was not originally included as one of the error domains in our template. A 'maximum dose' error domain was added after the team found poor compliance with maximum dose documentation in the first 3 weeks of data collection (online supplemental material 1).

Run charts showed that the intervention was not associated with any change in the frequency of errors in the domains of route (figure 2A) or frequency (figure 2B). The run chart for maximum dose errors (figure 2C) did show some improvement after the poster was introduced. A shift (circled) can be seen on the run chart from weeks 3 to 8 after intervention, with 7 points below the median. This indicates there was a non-random change to the prescribing process during this time. No trends or astronomical data points were present. Error rates over both the preintervention and postintervention period are summarised in online supplemental material 10.

### LESSONS AND LIMITATIONS

The main lesson learnt from this project was that prescribing is a multifaceted task that is the responsibility of not only the prescriber but also reviewers such as nursing staff and pharmacists. Kardexes were reviewed by nurses two times per day and less frequently by pharmacists. At the time of data collection, there was no set ward pharmacist. Lack of support during the review process may have contributed to why errors were not being picked up or communicated to doctors effectively at the time.

Abbreviations were the most common error and were unaffected by our poster intervention. Lessons were learnt from the interviews about likely causes. Both consultants said they would use abbreviations regularly (table 1). In contrast, two of the three junior doctors interviewed showed awareness that they were not supposed to abbreviate prescriptions. Importantly, both nurses were content with doctors using abbreviations if handwriting was legible. A previous qualitative study with 22 FY doctors found that senior doctors were seen to be highly influential to their prescribing behaviour through both informational (the influence of other people's knowledge and skills on our behaviour) and normative (the influence of what other people expect one to do) pathways. These interviews also revealed a common belief that prescribing errors are not likely to have consequences for patients.<sup>22</sup> This led us to reflect on the evidence about consequences of the abbreviations that were common in our ward. We found that the abbreviation 'PO' does not



**Figure 2** Run charts for the three most common as-required prescription errors preintervention and postintervention.

appear in the US Joint Commission's official 'Do Not Use' list of abbreviations<sup>23</sup> and is specifically included as safe in the Australian Commission on Safety and Quality in Healthcare's national recommendations.<sup>24</sup> The (°) abbreviation is not in the US 'Do Not Use' list, but the Australian recommendations say, 'Do not use symbols. Avoid, for example, "°2" to mean "every 2 hours."' However, it is not in their list of high-risk abbreviations.<sup>24</sup> An example of a high-risk abbreviation is 'U' for units. For example, prescription of 6iu (6 international units) has been interpreted as 61 units and prescription of 10U (10 units) has been interpreted as 100 units. In both cases, the patients

were harmed; the first was admitted to hospital and the second transferred to intensive care.<sup>25</sup> The lesson that we have learnt is that the abbreviations we identified are not high risk. Nonetheless, nursing staff find doctors' handwriting hard to read, and abbreviations exacerbate this problem (table 1). The policy on abbreviations applies to all hospital units in NHS Tayside, and consequently changing the policy on a single ward is not an option.<sup>1</sup>

None of the interviewees questioned the need to specify a maximum dose, yet our poster intervention was associated with a reduction in maximum dose errors (figure 2C). However, reduction in these errors began

**Table 1** Doctors' and nurses' attitudes to abbreviating prescriptions on a drug Kardex

Interviewee	Stance on abbreviations	Justification
Consultant A	Would abbreviate a prescription	<b>Habit</b> 'I would be used to writing "IM" and "SC" and "PO"'
Consultant B	Would abbreviate a prescription	<b>Common knowledge</b> '... everybody knows what "PO" and "IV" mean'
Registrar	Tries not to abbreviate	<b>Habit</b> 'I'm trying to stick to guidance as much as I can but it's with any of these things, sometimes you're so used to doing it a certain way'
FY1 A	Tries not to abbreviate	<b>Lack of space on Kardex</b> 'I try and avoid things like "TDS" and "QDS" if possible because I think it's easily misinterpreted so I try and avoid those. Again, sometimes space is an issue so even words like "maximum"; I'm going to cut that down to 'max' because there's no box in that Kardex that you can fit "maximum" into'.
FY1 B	Would abbreviate a prescription	<b>Lack of space on Kardex</b> 'there's no space to write that so I write 'Four times a day' and I know the nurses know what that means' '... I do use the 1 and a circle (°) for hourly and I know you're not supposed to do that but sometimes it's just not feasible'
Staff Nurse A	Confidence with reading abbreviations depends on doctors' handwriting quality	<b>Depends on Handwriting</b> 'Most of them I know but sometimes it will be like—sometimes it depends on the doctor's writing as well—it can look like something else as well, it can look like something else and you don't know what it's meant to say. Same with numbers and things as well, sometimes the way doctors write their numbers ... it can look like a completely different number if you know what I mean'.
Staff Nurse B	Is content with doctors using abbreviations	<b>Experience</b> 'I mean, I use PO when I'm doing it. Yeah, IM and SC and everything, I'm fine with that. Again, maybe brand-new staff would need to have it written out a bit better but I'm certainly okay with it because I know what they all mean. But someone might not know what Three times a day or BD means which is automatic because the doctors always put that, they're not going to put 'twice a day' or anything. I'm personally okay with it because I know what they all mean'.

before the intervention, which may have been due to a Hawthorne effect; the need to prescribe maximum doses was discussed with staff in the first 3 weeks of data collection when its documentation in the Kardex was found to be infrequent.<sup>26</sup> Despite improvement, the postintervention median for maximum dose errors was 22% (online supplemental material 10), which is well above the target of <5%. Interviewees identified lack of space on the Kardex as a major barrier to specifying maximum doses and eliminating abbreviations.

Only one person (SR) was responsible for all quantitative and qualitative data collection and analysis, which may have introduced unintentional bias to the project. The investigator visited the ward every week and therefore got to know ward staff, of whom some were also participants in qualitative interviews. Interviewer bias was avoided, where possible; however, participants could have felt influenced to answer questions in a certain way because of the investigator's role as a medical student.

The main limitation in this study lies in its generalisability, as the project took place in a single hospital ward.

As the sample size was low in terms of ward capacity (n=16), the findings from this study are unlikely to be generalisable to other areas. This weakens our project's sustainability as it renders us unable to benefit from spreading our project beyond our local area through word-of-mouth (diffusion) or poster redistribution (dissemination); these are key elements of a sustainable QI project according to the diffusion and dissemination paradigm.<sup>27 28</sup> As the ward contains a high volume of surgical patients, many Kardexes were with the patient in surgery at the time of data collection or were missing. This meant the sample size of Kardexes was low, with an average of seven available each week for audit.

Furthermore, other issues surrounding sustainability are important to consider as FYIs rotate every 4 months to a new area; the new cohorts would therefore have to be informed of the poster for it to be fully effective. As the lead researcher (SR) was a medical student based on the ward for 12 months, this was only possible for those who joined the ward during this period. Other team members were either not ward-based (PD and SG) or

were consultants (YB) who are only on the ward for a short space of time. This demonstrates how involvement from staff members working in the target environment is essential for the sustainability of an improvement project.

Our results show that a poster intervention alone is not sustainable or sufficient to improve all elements of prescribing on the ward. Around 70% of planned organisational change fails, and this is most often a result of design flaws in the planning stage of a project.<sup>27</sup> NHS Improvement divides this into three areas: staff, organisation and process.<sup>29</sup> More effort should have been made to involve our target group in the design of our project; this could have been done by conducting interviews earlier in the year during our preintervention stage. Organisational factors such as availability of prescribing tools and staff training could have been evaluated in more detail. Furthermore, the process-related benefits to the system could also have been evaluated, for example, does accurate prescribing make other parts of the system run more smoothly? More communication regarding the benefits of accurate PRN prescribing should have been made clear to patients, staff and the organisation to maximise sustainability.<sup>29</sup>

Our intervention was a simple, cost-effective method of eliciting improvement and was easy to distribute throughout the ward. However, this is a passive method of changing practitioner behaviour and did not bring PRN error rates down to our target of <5% by 6 months. A poster can also be easily moved or misplaced, which further impedes its efficacy, as PDSA cycle 1.2 demonstrated. The use of passive interventions such as posters to prevent erroneous behaviours has been successful<sup>30 31</sup>; however, evidence shows it is more effective when done in combination with an active intervention.<sup>32 33</sup> Qualitative interviews with ward staff were a strength of our project; by examining the contrasts and similarities between doctors and nurses on the ward, we had the opportunity to understand the views of our stakeholders. Solutions were also offered by interviewees such as providing more space to write in the Kardex. A key recommendation from this project is to involve the target population early to implement their views into the project design.

## CONCLUSION

This study aimed to improve documentation accuracy of as-required prescriptions on hospital inpatients' drug Kardexes. A poster intervention introduced to the ward was successful in reducing the ward's rates of maximum dose documentation errors but had no impact on abbreviations. Our work shows that passive dissemination of posters has some capacity to enact change in prescribing behaviour; however, we acknowledge that further progress with reducing prescribing errors on our ward is likely to require redesign of the drug Kardex to allow for more space to write prescriptions in full. The next steps for this project involve taking on board the suggestions from our

qualitative interviews to redesign a new Kardex for the ward to facilitate PRN prescribing.

Improving PRN prescribing involves a multisystem effort from doctors and nurses to encourage safe practice; however, outside pressures continue to impede this process.<sup>34 35</sup> A supportive approach to safety is required in healthcare to provide prescribers with the opportunity to learn from their errors to both inform their own and others' learning.<sup>4</sup> In addition to this, review of local guidance for abbreviations on prescriptions should be encouraged across all health boards

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**Contributors** SR was the lead researcher for the project and was responsible for the overall content of this paper. SR conducted all data analysis and interpretation. YB had the original idea for the project and was also involved in recruitment of qualitative interview participants for the project. PD and SG were responsible for designing the methodology of this project. PD, YB and SG provided feedback and comments regarding the content of this paper. SR submitted the paper.

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Date of Survey: \_\_ / \_\_ / \_\_

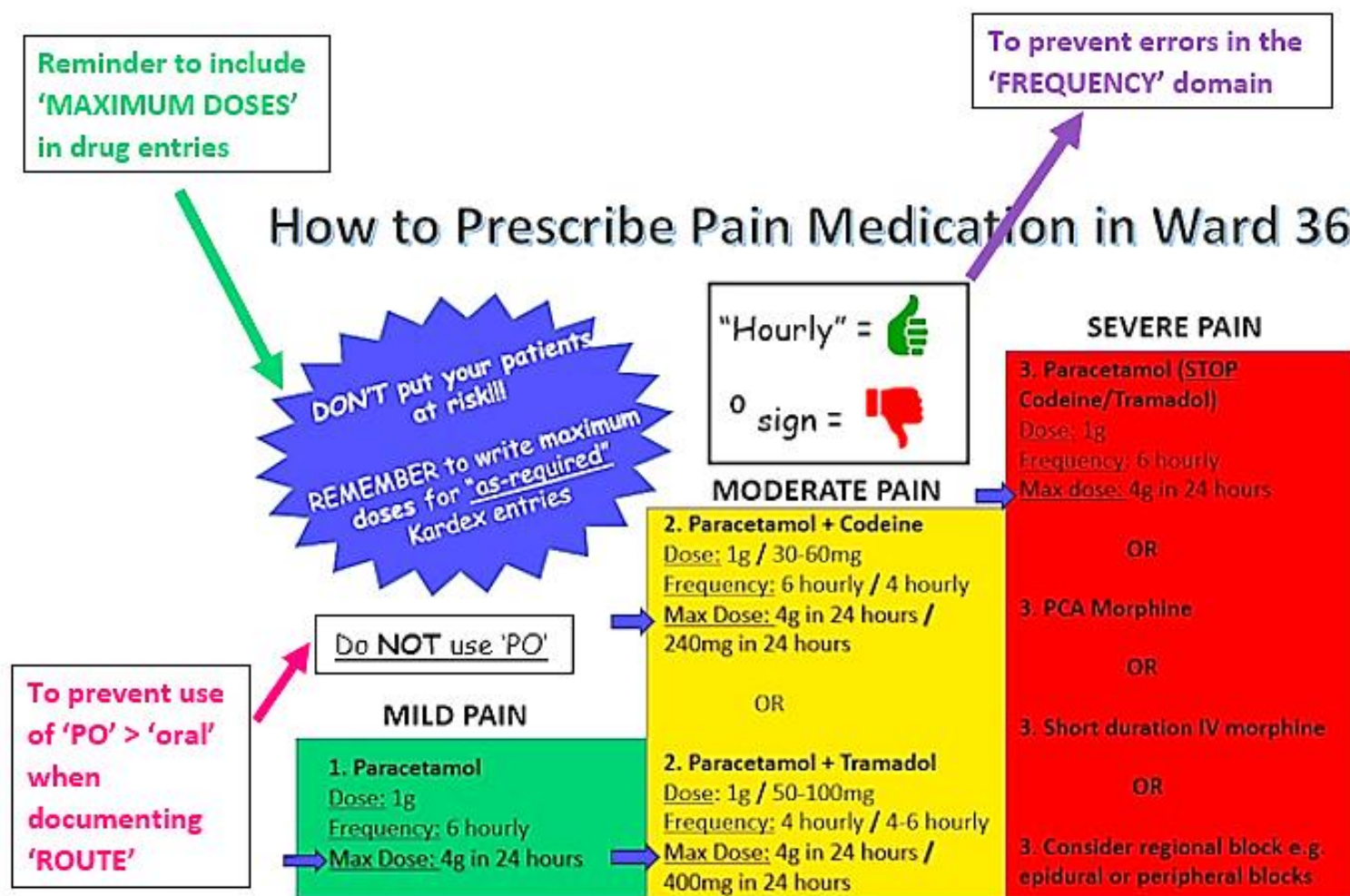
Location of Survey: \_\_\_\_\_

Patient (e.g Patient 1/2/3 etc)	Total no. of as- required prescriptions on Kardex	Total no. of as-required errors on Kardex	Name of as-required medications with errors  (please use generic drug name e.g paracetamol)	Reason for error(s)  (Choose from: - No maximum dose - Omission or abbreviation of drug frequency - Omission or abbreviation of drug route - No drug indication - Other)
<b>Example</b>  Patient 1	3	2	Paracetamol Codeine	No maximum dose, no drug indication Abbreviation of drug route

SUPPLEMENTARY MATERIAL 1: POINT PREVALENCE SURVEY (PPS) TEMPLATE

<b>ID</b>	Intradermal
<b>IM</b>	Intramuscular
<b>IV</b>	Intravenous
<b>SCut</b>	Subcutaneous
<b>PCA</b>	Patient Controlled Analgesia
<b>INH</b>	Inhalation
<b>PR</b>	Rectal
<b>SLing</b>	Sublingual
<b>TOP</b>	Topical
<b>Oral</b>	Oral
<b>NKA</b>	No Known Allergies

SUPPLEMENTARY MATERIAL 2: LIST OF ACCEPTED ABBREVIATIONS ACCORDING TO NHS TAYSIDE'S SAFE AND SECURE HANDLING OF MEDICINES GUIDELINE  
[1]



SUPPLEMENTARY MATERIAL 3: POSTER INTERVENTION WITH HIGHLIGHTED ERROR DOMAINS



Q1. Tell me about yourself.

- What is your current role?
- How long have you had this role?

Q2. Can you talk me through a typical day in your role?

- Talk me through your day yesterday.

Q3. How much of your day do you spend prescribing?

- What about the amount of time you spend looking at prescriptions?
- Do you feel you have enough time in your day to do this properly?
- How important would you say prescribing is in relation to all the other tasks you have to do?

Q4. Can you describe how you fill in a Kardex for a newly admitted patient?

- How would you then go about prescribing an as-required medication such as codeine to a patient on the ward?

Q5. How confident are you with regards to prescribing as-required medication?

- What do you think you do well with?
- What part of this do you find most difficult and why?
- What are your thoughts on the use of abbreviations when writing prescriptions?
- If you weren't sure about a prescription, what would you do?

Q7. Have you noticed anything that makes prescribing difficult in your ward?

- How often would you say you are interrupted when prescribing?
- How would you describe the ward environment you work in?

Q8. What are your thoughts on the current Kardex form used for prescriptions in your ward?

- Does it facilitate prescription writing in any way?
- Does it impede prescription writing in any way?
- Is there anything you think needs improvement?
- Do you think some documentation errors on the Kardex are more serious than others?

Q9. What do you think would make prescribing as-required medication easier for you?

- How easily do you think these ideas could be implemented in your ward environment?

Q10. Do you have anything further to add?

#### SUPPLEMENTARY MATERIAL 4: INTERVIEW TOPIC GUIDE FOR DOCTORS

Q1. What is your current role?

- How long have you had this role?
- Who are the main team members that you work with?

Q2. Can you talk me through a typical day in your role?

Q3. How much of your day do you spend administering medication to patients?

- When in the day do you do this?
- How much time do you spend looking at prescriptions on the drug Kardex?
- Do you feel you have enough time in your day to do this properly?
- How important would you say administering medication is in relation to all the other tasks you have to do?

Q4. Can you describe the process you take when giving a drug to a patient from when the doctor writes on the Kardex?

Q5. How confident are you with administering as-required drugs such as paracetamol?

- What do you think you do well?
- What part of this do you find most difficult and why?
- What are your thoughts on doctors' uses of abbreviations on the drug Kardex in terms of patient safety?
- If you weren't sure about a prescription, what would you do?

Q7. Is there anything that makes prescribing difficult in your ward?

- How would you describe the ward environment you work in?

Q8. What are your thoughts on the current Kardex form used for prescriptions in your ward?

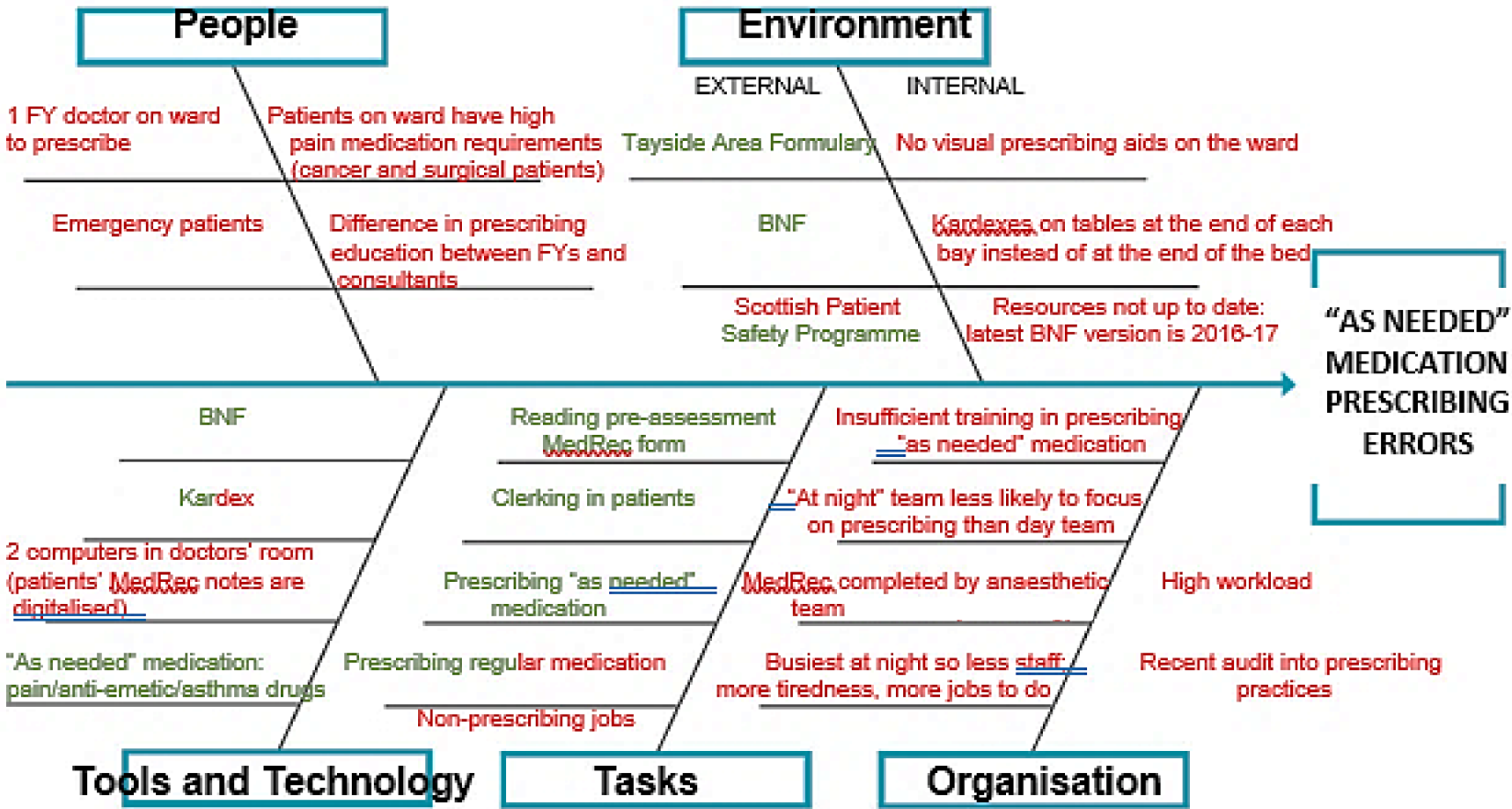
- Does it make it easy to administer medication?
- Does it impede this in any way?
- Is there anything you think needs improvement?

Q9. What do you think would reviewing as-required Kardex prescriptions easier for you?

- How easily do you think these ideas could be implemented in your ward environment?

Q10. Do you have anything further to add?

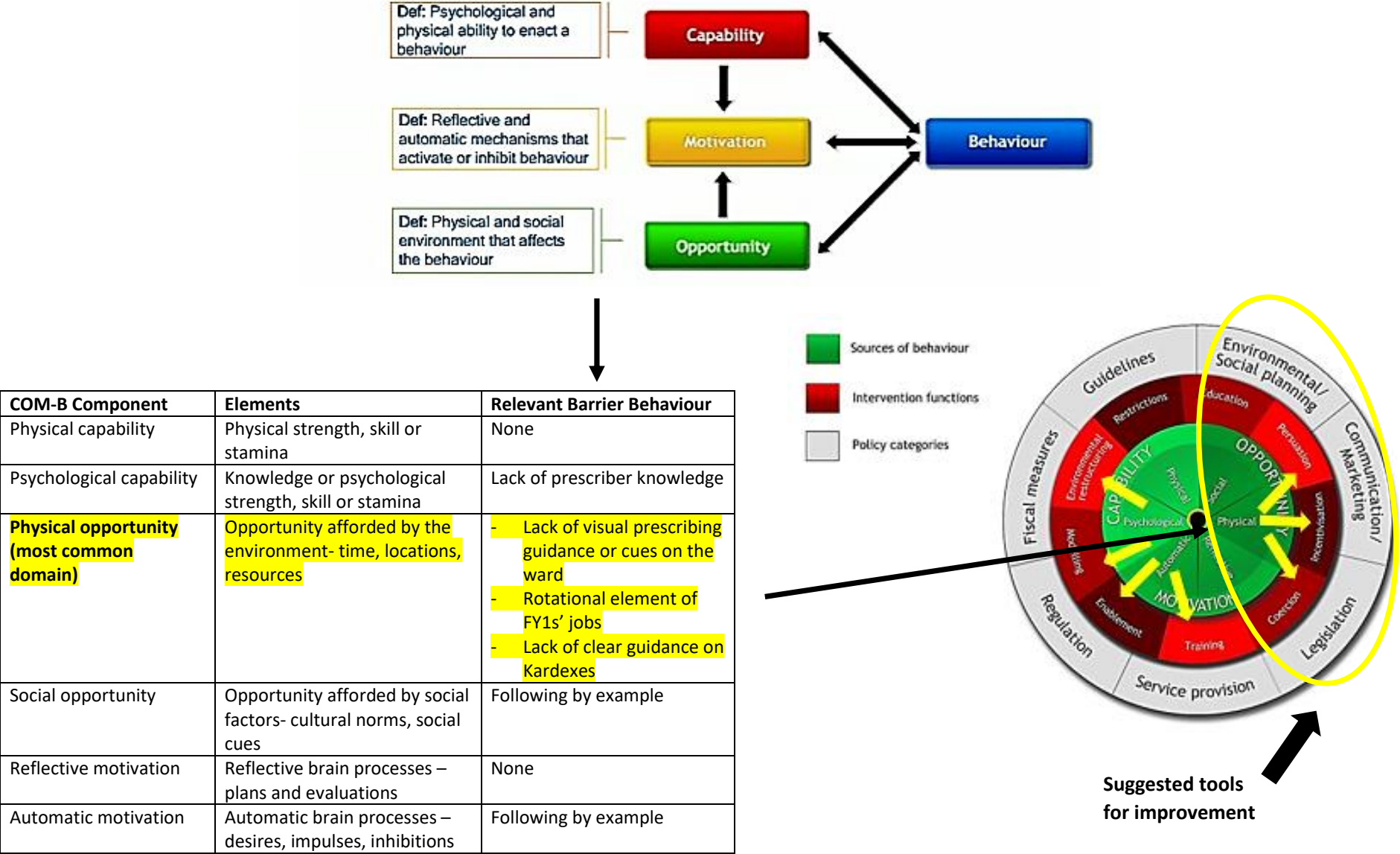
#### SUPPLEMENTARY MATERIAL 5: INTERVIEW TOPIC GUIDE FOR NURSES



Red = Barriers to accurate PRN prescribing

Green = Facilitators for accurate PRN prescribing

SUPPLEMENTARY MATERIAL 6: CAUSE AND EFFECT DIAGRAM OF PRN PRESCRIBING ERRORS ON THE WARD

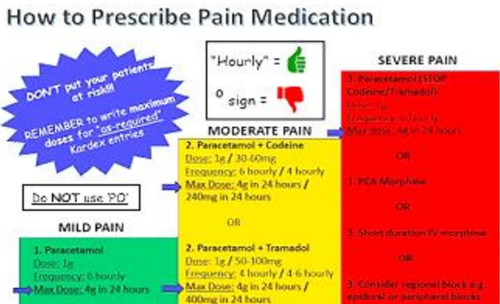


SUPPLEMENTARY MATERIAL 7: USE OF BEHAVIOUR CHANGE THEORY TO CHOOSE AN APPROPRIATE INTERVENTION [20]



PDSA Cycles	1.1	1.2	1.3
Plan	Utilise existing pain guidelines to form the content of our poster.	Retrieve up-to-date pain ladder guidelines to create an A4 pain ladder poster for the noticeboard.	Print out extra posters to incorporate into other prescribing environments on the ward such as the nurses' tables and the dispensing room.
Do	We searched Tayside Area Formulary for an appropriate pain ladder to use to create the template, however access wasn't available through this. NICE and SIGN also did not have a visible pain ladder within their guideline content.	Guidelines were retrieved and the pain ladder template was copied into the poster. Colour was added to mark the different steps from mild pain to severe pain. The poster was put up on the noticeboard in the ward doctors' room on 20/1/20.	Laminated posters were added to each area in easily visible places to maximise ease of access of the poster.
Study	The lack of pain ladder content on the Tayside Area Formulary was presumably because the content was being accessed via a personal computer instead of an NHS computer.	The practicality of the location was assessed on 27/1/20 and it was found that the poster had been moved behind other documents on the noticeboard by a member of staff.	The posters were not moved by staff members. The researcher discussed the posters with FY1 doctors who stated these were locations. There was a 39.2% decrease in errors after the poster was introduced.
Act	We accessed an NHS computer with Staffnet to print out the most recent pain ladder guidelines for Tayside; this can then be used as a template to create a ward pain ladder poster.	A more effective noticeboard location for the poster was sought and it was decided that the poster be included in other areas of the ward where prescribing took place.	Continue using these locations for the posters.

1.1 and 1.2



1.3



SUPPLEMENTARY MATERIAL 8: POSTER INTERVENTION HIGHLIGHTING HOW TO PRESCRIBE PAIN MEDICATION

SAFETY				
Confidence	Guidelines vs Mindlines	Outside Influences on Prescribing	The Prescribing Environment	The Ward Kardex
<ul style="list-style-type: none"> <li>• Confidence in prescribing</li> <li>• Consultants' lack of a prescribing role</li> <li>• FY1s roles vs consultants roles</li> <li>• Lack of confidence in prescribing</li> <li>• Experience</li> <li>• Lack of prescribing in daily role</li> <li>• Opinions of themselves as a prescriber</li> <li>• Presence of a pharmacist on the ward</li> <li>• Support from seniors</li> <li>• Uncertainty</li> </ul>	<ul style="list-style-type: none"> <li>• Accessing guidance</li> <li>• Changes to prescribing protocol over time</li> <li>• Hierarchy for information</li> <li>• Maximum doses</li> <li>• Pharmacist's role</li> <li>• Relying on common knowledge</li> <li>• Tayside Area Formulary</li> <li>• Using abbreviations</li> <li>• Using the BNF</li> <li>• Variation in practice</li> </ul>	<ul style="list-style-type: none"> <li>• Relationship between doctors and nurses</li> <li>• Social barriers to prescribing safely</li> <li>• Tense environment</li> <li>• Patient involvement in prescribing</li> </ul>	<ul style="list-style-type: none"> <li>• Busy ward</li> <li>• Delegating tasks</li> <li>• Duration and frequency of prescribing</li> <li>• Giving feedback</li> <li>• Improvement ideas</li> <li>• Interruptions when prescribing</li> <li>• Lack of a main prescriber</li> <li>• Lack of confidentiality in the doctors' room</li> <li>• Lack of staff</li> <li>• Lack of time to prescribe properly</li> <li>• More prescribers</li> <li>• Prescribing culture</li> <li>• As-required prescribing</li> <li>• Prioritisation</li> <li>• Reviewing prescriptions</li> <li>• Staff turnover</li> <li>• Workload</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of space</li> <li>• Physical barriers to prescribing</li> <li>• Pre-printed Kardex</li> <li>• Prescribing pain ladder</li> <li>• Writing up Kardexes</li> </ul>

SUPPLEMENTARY MATERIAL 9: THEMES FROM QUALITATIVE ANALYSIS OF INTERVIEWS

Week	Percentage of patients with a 'route' error on their Kardex (%)	Percentage of patients with a 'frequency' error on their Kardex (%)	Percentage of patients with no maximum dose written (%)
<b>Pre Int 2</b>	100	100	No data
<b>Pre Int 3</b>	71.4	85.7	No data
<b>Pre Int 4</b>	50	50	100
<b>Pre Int 5</b>	83.3	83.3	83.3
<b>Pre Int 6</b>	25	87.5	87.5
<b>Pre Int 7</b>	100	100	66.7
<b>Post Int 1</b>	25	62.5	50
<b>Post Int 2</b>	100	100	50
<b>Post Int 3</b>	80	100	20
<b>Post Int 4</b>	100	100	0
<b>Post Int 5</b>	66.7	83.3	0
<b>Post Int 6</b>	80	40	40
<b>Post Int 7</b>	54.4	54.4	27
<b>Post Int 8</b>	50	75	25
<b>Median</b>	<b>75.7</b>	<b>84.5</b>	<b>45</b>
<b>Pre-intervention median</b>	<b>77.35</b>	<b>86.6</b>	<b>75.5</b>
<b>Post-intervention median</b>	<b>73.35</b>	<b>79.15</b>	<b>22.5</b>

SUPPLEMENTARY MATERIAL 10: TABLE SUMMARISING PERCENTAGE DECREASE IN NUMBER OF ERRORS PER PRESCRIPTION

